Appendix C

CONTROL TECHNOLOGY 326 IAC 8-1-6 BACT ANALYSIS

MGPI of Indiana

Source Background and Description

Source Name:	**MGPI of Indiana**
Source Location:	**7 Ridge Ave., Lawrenceburg, IN 47025**
County:	**Dearborn**
SIC Code:	**2085**
Significant Source Modification No.:	**029-35496-00005**
Significant Permit Modification No.:	**029-35505-00005**
Permit Reviewer:	**Kristen Willoughby**

On February 23, 2015, MGPI of Indiana submitted an application to the OAQ requesting the construction of a new DDG dryer.

The proposed modification is subject to 326 IAC 8-1-6 (BACT) review for VOC because the new DDG dryer has a potential to emit of VOC greater than or equal to 25 tons per year.

The BACT analysis submitted by MGPI of Indiana, which has been reviewed and analyzed by IDEM, OAQ, is based on the draft "Top-Down approach: BACT Guidance" published by USEPA, Office of Air Quality Planning Standards, March 15, 1990. The BACT analysis has been based on the following sources of information which have been reviewed or contacted:

(a) Downloadable USEPA RACT/BACT/LAER Clearinghouse (RBLC) System;
(b) USEPA/State/Local Air Quality Permits;
(c) Federal/State/Local Permit Engineers;
(d) Control Technology Vendors; and
(e) Inspection/Performance Test Reports.
(f) OAQPS Control Cost Manual.

BACT Definition and Applicability

Federal guidance on BACT requires an evaluation that follows a "top down" process. In this approach, the applicant identifies the best-controlled similar source on the basis of controls required by the regulation or the permit, or the controls achieved in practice. The highest level of the control is then evaluated for technical feasibility.

The five basic steps of a top-down BACT analysis are listed below:

Step 1: Identify Potential Control Technologies

The first step is to identify potentially "available" control options for each emission unit and for each pollutant under review. Available options should consist of a comprehensive list of those technologies with a potentially practical application to the emissions unit in question. The list should include lowest achievable emission rate (LAER) technologies, innovative technologies and controls applied to similar source categories.

Step 2: Eliminate Technically Infeasible Options

The second step is to eliminate technically infeasible options from further consideration. To be considered feasible, a technology must be both available and applicable. It is important in this step that any presentation of a technical argument for eliminating a technology from further consideration be clearly documented based on physical, chemical, engineering and source-specific factors related to safe and successful use of the controls.

Step 3: Rank The Remaining Control Technologies By Control Effectiveness

The third step is to rank the technologies not eliminated in Step 2 in order of descending control effectiveness for each pollutant of concern. If the highest ranked technology is proposed as BACT, it is not necessary to perform any further technical or economic evaluation, except for the environmental analyses.

Step 4: Evaluate The Most Effective Controls And Document The Results

The fourth step entails an evaluation of energy, environmental and economic impacts for determining a final level of control. The evaluation begins with the most stringent control option and continues until a technology under consideration cannot be eliminated based on adverse energy, environmental, or economic impacts.

Step 5: Select BACT

The fifth and final step is to select as BACT the most effective of the remaining technologies under consideration for each pollutant of concern. BACT must, at a minimum, be no less stringent than the level of control required by any applicable New Source Performance Standard (NSPS) and National Emissions Standard for Hazardous Air Pollutants (NESHAP) or state regulatory standards applicable to the emission units included in the permits.

DDG Dryer

VOC emissions from the DDG dryer (EU-39) are based on calculations provided by the source. The potential to emit VOC from the DDG dryer (EU-39) is greater than 25 tons of VOC per year. Therefore, Best Available Control Technology (BACT) is required to be applied to the DDG dryer (EU-39).

Step 1 – Identify Control Options

Any control technology chosen must be able to effectively reduce VOC emissions in the dryer exhaust stream given the following characteristics:

- Maximum flow rate of approximately 30,000 acfm.
- High dryer exhaust temperature (approximately 215°F).
- High moisture content resulting from water driven off from the DDG within the dryer.

An RBLC search did not locate entries for distilled spirits production, so the search instead focused on recent applications of BACT at DDG dryers located within dry mill fuel ethanol facilities. Though facilities engaged in fuel ethanol production are typically on a much larger scale than MGPI's facility, the process of producing DDG from spent stillage at MGPI shares a common principal of operation with the similar process at fuel ethanol plants. The technologies applied for control of VOC emissions from direct-fired DDG dryer exhaust at fuel ethanol plants are therefore considered to be potentially applicable for MGPI's proposed direct-fired dryer.

The following control technologies were identified and evaluated to control VOC emissions from the DDG dryer (EU-39).

(a) Thermal Oxidation;

(b) Flares;

(c) Condensers;

(d) Carbon Adsorption;

(e) Wet Scrubber; and

(f) Catalytic Oxidizer.

Step 2 – Eliminate Technically Infeasible Control Options

The test for technical feasibility of any control option is whether it is both available and applicable to reducing VOC emissions from the DDG dryer (EU-39). The previously listed information resources were consulted to determine the extent of applicability of each identified control alternative.

(a) Thermal Oxidization

Thermal oxidizers are refractory lined enclosures with one or more burners in which the waste gas stream is routed through a high temperature combustion zone where the waste gas stream is heated and the combustible materials are burned. Thermal oxidizers typically operate at a range from 1400 to 1600 degrees Fahrenheit, depending on the compounds in the waste gas stream being controlled. The residence time for a thermal oxidizer typically ranges from 1 to 2 seconds. Combustion at high operating temperatures and design residence time enables thermal oxidizers to efficiently control VOC emissions from a variety of waste streams.

Thermal oxidation units typically employ some form of heat recovery. Heat-recovery type thermal oxidizers recover the heat generated by the combustion of the VOC laden waste gas stream to assist in the thermal oxidizer operation. There are two types of heat-recovery thermal oxidizers: recuperative and regenerative. Recuperative thermal oxidizers pass the hot combustion gas generated in the combustion zone through a heat exchanger to preheat the unburned waste gas prior to the combustion zone. Regenerative thermal oxidizers (RTOs) use the hot combustion gases to heat a ceramic bed which then heats the incoming waste gas stream up to or near the destruction temperature of VOCs. Additional heat is typically required in an RTO to heat the gas to the designed destruction temperature. Direct-flame type thermal oxidizers heat the exhaust stream to destruction temperature and vent the hot gas. Direct-flame thermal oxidizers do not preheat the inlet gas stream but energy can be recovered from the thermal oxidizer using the hot exhaust gas to generate steam or hot water for the facility.

(b) Flares

Flares are commonly used to oxidize organic materials at high temperatures. Flares can be constructed so that the waste gas stream is sent up a stack (usually greater than 10 meters in height) and burned at the tip of the stack. These flares burn supplemental fuel at the tip of the flare stack using a pilot flame to create a high temperature combustion zone to burn the waste gas.

Enclosed flares consist of multiple burners in refractory-lined enclosures that allow for longer residence times and therefore, result in high destruction efficiencies. Flares are similar, in terms of level of control and enclosure design, to thermal oxidization units; however, flares do not maintain a constant combustion zone temperature. Flares can require supplemental gas to "enrich" the waste gas stream. Waste streams controlled by flares typically have at least 200 to 300 British thermal units (Btu) of combustible constituents per cubic foot (CF) of waste gas for flares to be an effective control technology.

Flare performance depends on the flame temperature, the residence time of the vent gas in the combustion zone, the degree of mixing within the gas stream, and the amount of oxygen available to prevent free radical formation. Since flares do not maintain a constant combustion zone temperature, they require supplemental natural gas to enrich the waste gas stream if the VOC concentration is low. In order to increase the heat value of the DDG dryer exhaust gases, natural gas must be added to the exhaust gasses prior to the flare.

(c) Condensers

Condensers are used to separate materials from gaseous streams typically by cooling and, in some cases, pressurizing a gas stream to cause some of the constituents to condense to a liquid form. Condensers are designed to separate constituents based on the difference in dew points of the compounds that are targeted for separation.

The most common types of condensers are surface and contact condensers. Surface condensers use indirect contact heat exchange in which the coolant does not contact the gas stream directly. Most surface condensers are shell and tube type heat exchangers in which the coolant passes through tubing and a VOC laden gas stream which passes on the outside of the tubes but inside the heat exchanger shell, condenses the VOCs on the outside of the tubes. Contact condensers, however, cool the gas stream by spraying either an ambient-temperature or chilled liquid directly into the gas stream. Spent coolant containing the VOCs from contact condensers usually cannot be reused directly and requires further processing to recover the spent coolant. As a result, the spent coolant is often treated as a waste product that is shipped off-site for recovery. Since contact condensers have environmental and process engineering disadvantages, only surface condensers are addressed in this control technology analysis.

The DDG dryer exhaust characteristics make the control of VOC emissions with a condenser inappropriate. An inordinately large amount of energy would be required to cool the relatively large volume exhaust air stream from its exit temperature of approximately 215°F to a temperature where ethanol (and the other VOC constituents in the vent stream) would condense in appreciable amounts, especially given their relatively low vapor concentrations that translate to very low dew points. Therefore, condenser controls are considered to be technically infeasible and are rejected as BACT for control of VOC from the proposed direct fired dryer.

(d) Carbon Adsorption

Carbon adsorption is a control technology often used to remove organic compounds from gaseous or liquid streams. Carbon adsorption uses a contact vessel to pass the waste gas stream through an activated carbon bed. The organic compounds in the waste gas stream are collected at the interface of the activated carbon by intermolecular forces (such as Van der Waals' interactions) creating a VOC-rich carbon. The VOC-rich carbon is then removed from the carbon bed and new, or "clean", activated carbon is added to the bed. The VOC-rich carbon is reclaimed (i.e., converted back to "clean" carbon) by separating the VOCs from the carbon. This separation process is typically achieved by stripping the carbon in an oxygen deficient environment usually using steam as the stripping media to vaporize the organic material without burning the carbon or the VOCs.

Carbon adsorption has not been demonstrated on an industrial scale for control of VOC from DDG drying operations. Due to the relatively low VOC concentration in the dryer exhaust stream and its relatively high moisture content, the potential would exist for condensation of water which could block effective carbon surface area. Dehumidification of the stream would be necessary, which would involve cooling the hot dryer exhaust vent. This additional process step is not considered to be technically feasible. Even if dehumidification were achieved, the potential effectiveness of activated carbon controls is severely limited due to the low concentration of VOC in the exhaust stream for control. Therefore, carbon adsorption controls are considered to be technically infeasible and are rejected as BACT for control of VOC from the proposed direct fired dryer.

(e) Wet Scrubbers
There are several types of wet scrubbers that use a variety of techniques to control VOC emissions. The type of scrubber used in a particular application is dependent on the characteristics of the waste gas stream and the pollutants of concern. VOC control scrubbers are designed primarily for creating intimate contact to promote absorption of soluble compounds.

Absorption scrubbers come in a variety of designs but operate on the same primary absorption principles. An absorption scrubber typically consists of a contact tower with a high surface area material (mass transfer material) in the middle. A scrubbing liquid is sprayed down the tower covering the mass transfer material as waste gas is blown in the bottom of the tower, creating intimate contact between the liquid and gas. The soluble gaseous compound(s) then dissolves in the scrubbing liquid. The scrubbing liquid is then removed from the bottom of the tower and treated. The two predominant types of absorption scrubbers are packed and plate towers. Packed towers are vertical vessels that are filled with a packing material such as Raschig Rings or “saddle” shaped pieces of material. This packing creates significant surface area for the liquid and gas to contact. Plate towers are vertical vessels with horizontal sieve plates in the middle. The scrubbing liquid is sent down the tower filling the plate and the gas passes through the plate’s holes generating contact with the scrubbing liquid. Packed towers are more efficient; however, plate towers are used when there is significant particulate matter in the waste gas stream because packed towers are susceptible to clogging when the waste gas stream contains significant PM. Because the VOC streams evaluated in this BACT analysis do not contain significant particulate matter, packed bed towers are the most effective wet scrubbers for reducing VOC emissions (based on cost and control) in this industry and is, therefore, the only scrubber evaluated for VOC control.

(f) Catalytic Oxidizers
Catalytic oxidizers are similar to thermal oxidization in that the units are enclosed structures that use heat to oxidize the combustible materials. Catalytic oxidation, however, heats the waste gas stream in the presence of a catalyst. The catalyst decreases the necessary operating temperature for the VOCs to oxidize and may potentially increase the efficiency of the oxidation unit. However, the disadvantages of catalytic oxidation include catalyst selectivity (catalyst may not be effective on some of the targeted compounds), catalyst cost (catalysts need to be replaced on a regular basis), and catalyst fouling (particulate matter and other pollutants can foul or degrade catalysts).

Catalytic oxidizers use a catalyst to lower the operating temperature of the oxidation unit. The catalyst must remain effective during operation in order for the control efficiency of the device be maintained. Fouling of the catalyst will rapidly decrease the control efficiency. The catalyst material used for catalytic oxidation has small channels for the waste gas stream to flow through. As a result, particulate matter in the dryer exhaust streams is likely to accumulate in the catalyst material, thereby fouling the catalyst and reducing the control efficiency. For this reason, OAQ has concluded that catalytic oxidation is an unreliable control technology for the DDG dryer because of the presence of particulates in the exhaust gasses.

Step 3 – Rank Remaining Control Technologies by Control Effectiveness

The remaining control options are in order of descending control effectiveness:

(a) Thermal Oxidization - ~~99~~98%

(b) Flares - 98%

(c) Wet Scrubber - 98%

Step 4 – Evaluate the Most Effective Controls and Document Results

Since each technology is capable of achieving an equivalent level of control (98% of VOC emissions), either thermal oxidation, wet scrubbing, or flaring could be considered the top-ranked control. According to USEPA Guidance (New Source Review Workshop Manual, Draft October 1990), "…an applicant proposing the top control alternative need not provide cost and other detailed information in regard to other control options. In such cases the applicant should document that the control option chosen is, indeed, the top, and review for collateral environmental impacts."

Of the three alternatives, thermal oxidation is by far the most commonly used control in practice for control of VOC emissions from DDG drying operations, as listed in the table below.

Company	RBLC ID	Source	Permit Issuance Date	Technology	VOC Limit(s)
Homeland Energy Solutions, LLC, PN 06-672	IA-0089	HRSG from Dryers and Gasification	08/08/2007	TO	98% or 0.006 lb/MMBtu, 6.57 tpy
Archer Daniels Midland	IA-0088	Fermentation Process and Indirect-fired DDGS Dryer	06/29/2007	Route Process Off-gasses through the Dryers Combustion Chamber	98%, 3.16 lb/hr
Southwest Iowa Renewable Energy	IA-0092	DDGS Dryers and Distillation	04/19/2007	TO	99% or 10 ppmv, 5.11 lb/hr
MGP Ingredients of Illinois	IL-0105	Feed Dryer D6500	01/25/2006	Eco-dry system or other comparable system that passes exhaust through the dryer	0.12 lb/MMBtu 3 - hr average
Heartland Corn Products	MN-0062	DDGS Dryer Operation #1	12/22/2005	TO	95%, 8.87 lb/hr
Heartland Corn Products	MN-0062	DDGS Dryer Operation #2 (includes beer stripper, recitifier, side stripper, molecular sieve, evaporator, and storage tanks)	12/22/2005	TO	95%, 15.26 lb/hr

Note: Several State BACTs were issued under 326 IAC 8-1-6 for this SIC code. However, these facilities are now subject to the State RACT under 326 IAC 8-5-6. Therefore, these have not been included in this discussion.

Other considerations with respect to environmental and energy impacts are listed below:

- Thermal oxidation and flaring, unlike wet scrubbing, do not result in the generation of another process stream (scrubber water) requiring subsequent treatment or disposal.

- Thermal oxidation provides similar control to flaring, but operates more efficiently, particularly in the case of an RTO where a substantial portion of the waste heat is recovered and used to pre-heat the incoming vent stream for treatment (typical thermal efficiencies in excess of 90%).

- Additional energy requirements (i.e., natural gas consumption) would be necessary to operate an RTO. In the case of MGPI, however, this impact is countered by the fact that under normal facility operation as proposed, the direct-fired dryer would operate in lieu of the facility's existing steam tube dryers. The increased natural gas use at the proposed dryer/controls would be balanced by a decrease in steam demand at the steam tube dryers. Natural gas consumption by the facility's existing boilers would therefore decrease. MGPI estimates that, under current operations with steam tube drying, approximately 1,120 Btu steam energy are required per pound of water evaporated. When the proposed direct-fired dryer and controls are in operation, this rate is expected to remain essentially the same for a given evaporative load.

- Thermal oxidation provides effective reduction of HAP emissions contained in the DDG dryer exhaust, representing the elimination of an adverse environmental impact that would result from its implementation.

Based on the reasons listed above, thermal oxidation is the most advantageous of the top ranked technologies with respect to environmental and energy impacts.

MGPI has proposed the use of an RTO with 98% overall control efficiency and a 1.91 lb/hr limit for the new dryer.

The proposed pound per hour limit is more stringent than other pound per hour limits found in the RBLC. Therefore, the proposed limit will be BACT.

IDEM is aware that that the above control technologies may be able to periodically achieve control efficiencies that exceed 98% under certain operating conditions. However, BACT must be achievable on a consistent basis under normal operational conditions. BACT limitations do not necessarily reflect the highest possible control efficiency achievable by the technology on which the emission limitation is based. The permitting authority has the discretion to base the emission limitation on a control efficiency that is somewhat lower than the optimal level. There are several reasons why the permitting authority might choose to do this. One reason is that the control efficiency achievable through the use of the technology may fluctuate, so that it would not always achieve its optimal control efficiency. In that case, setting the emission limitation to reflect the highest control efficiency would make violations of the permit unavoidable. To account for this possibility, a permitting authority must be allowed a certain degree of discretion to set the emission limitation at a level that does not necessarily reflect the highest possible control efficiency, but will allow the Permittee to achieve compliance consistently. While we recognize that greater than 98% may be achievable as an average during testing, IDEM allows for sources to include a safety factor, or margin of error, to allow for minor variations in the operation of the emission units and the control device.

Step 5 – Select BACT

The following is the VOC BACT for the DDG dryer:

(a) The VOC emissions from the DDG dryer (EU-39) shall be controlled by an RTO.

(b) The RTO shall operate with an overall control efficiency, which includes capture and destruction efficiencies, of not less than 98%.

(c) The VOC emissions from the DDG dryer (EU-39) shall not exceed 1.91 lb/hr.